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# ZOOLOGICAL SCIENCES

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# Canadian Journal of Research

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## STUDIES ON CESTODES OF THE GENUS *TRIAENOPHORUS* FROM FISH OF LESSER SLAVE LAKE, ALBERTA

### III. NOTES ON *TRIAENOPHORUS NODULOSUS* (PALLAS) IN THE SECOND INTERMEDIATE HOST[1]


BY RICHARD B. MILLER[2]



### Abstract

The plerocercoids of *T. nodulosus* were found in their earliest stages in the livers of burbot fry (*Lota lota maculosa*) in early July. At this time the worms occur scattered throughout the liver tissue, not enclosed in cysts. The anlagen of the scolex hooks are present.

Later in July the cyst wall has developed and the plerocercoids are provided with a scolex identical with the adult structure. The cysts are small and compact and the contained worms strongly coiled in contrast to their earlier, diffuse state.

During the second summer the plerocercoids begin to degenerate, the process proceeding from the posterior end forward. No burbot older than yearlings were found to contain cysts.

A brief summary of the life history of *T. nodulosus* is given.


In Part I of these studies (4) the maturation of the adults of *Triaenophorus nodulosus* in the intestine of the pike (*Esox lucius*) was described. Ripe eggs are produced mainly during the last week in May and in early June. In Part II (5) the coracidia and the procercoid stage in *Cyclops bicuspidatus* were described. The procercoid matures in the copepod in from 10 days to two weeks. Hence from mid-June to mid-July early infections of the second intermediate host should be available.

Cooper (1) found plerocercoid stages of this species in *Perca flavescens*, *Micropterus dolomieu*, *Catostomus commersonnii*, and *Notropis delicatus*. Scheuring (7) reports the encysted plerocercoids in the organs, especially liver, of 30 different species of European freshwater fishes, but mainly in the perch. Cross (2) reports the encysted plerocercoid from perch, suckers, smallmouth bass, and bluegills of the Trout Lake region in Wisconsin.

During the summers of 1942 and 1943 the author examined perch of all sizes from Lesser Slave Lake. On June 4, 1942, 40 yearling perch, 5 to 6 cm. long, were examined. No *Triaenophorus* cysts were found. From June 13 to June 30 of the same year, 30 more yearling perch were examined with the same result. In the same period the viscera of an unrecorded number of adult perch were examined but no *Triaenophorus* cysts were found.


[1] *Manuscript received October 2, 1944.*
*Contribution from the Department of Zoology, University of Alberta, Edmonton, Alta.*



[2] *Assistant Professor of Zoology.*

In July, 1943, perch of the year, from 2 to 3 cm. long, were examined; no plerocercoids were found.

It must be concluded that the perch in Lesser Slave Lake do not serve as second intermediate hosts for *Triaenophorus nodulosus*. The possible reason for this is discussed below.

In further searches for the second intermediate host the following species of fish were examined without success,—*Percopsis omiscomaycus*, *Esox lucius*, *Notropis hudsonius*, *Catostomus commersonii*, and *Catostomus catostomus*.

During the winter of 1942 the viscera of 100 adult burbot (*Lota lota maculosa* (Le Sueur) ) were examined. No *Triaenophorus* parasites were found.

An encysted plerocercoid of *Triaenophorus nodulosus* was finally found in the liver of a small, partly digested burbot[1], from the stomach of a pike. Because of this find, several collections of small burbot were made at Lesser Slave Lake during the summers of 1943 and 1944. A study of the livers of these gives a fairly complete picture of the development of the plerocercoids of *T. nodulosus*.

The earliest collection was made July 11, 1943. The burbot were 2 to 3 cm. long and clearly belonged to the hatch of that spring. The livers of 90% of them were infested with white worms, from two to 20 of them per infected liver; the average was seven. The worms varied from 0.5 to 10 mm. in length; a small indentation was visible at each end; one of these, at the broader end, was evidently the remains of the frontal gland of the procercoid (Rosen's (6) third bothrium); the other was interpreted as the excretory pore. In the larger specimens the anlagen of the four scolex hooks could be distinguished (Fig. 1).

The worms had penetrated the liver to a most remarkable extent; the longer worms stretched through the greater part of the liver with only slight coiling of their bodies. In the heavily infected livers scarcely a particle of liver tissue was left untouched; the parasites formed a loose network throughout the whole liver substance. No suggestion of cyst walls was found in this collection; surrounding the worms in the liver were many blood and detached liver cells, dissolved, according to Scheuring (7), by the action of a powerful tissue ferment released by the parasite. The holes in the liver surfaces made by the parasites in their entry were still visible and in a few the posterior portions of the worms were still protruding from them. Obviously the worms had entered the liver from the coelom.

Collections of burbot fry earlier than July 11 were not obtained so that the author has not seen the process of boring through the gut wall into the body cavity—a process first described by Rosen (6) in young perch. Janicki (3) also found these worms in young perch livers and gave them a new term 'mesocercoid'. He believed them to be a distinct stage in the life cycle, of equal rank to procercoid and plerocercoid. Scheuring's (7) detailed histological studies of cyst formation by *T. nodulosus* in several species of fish indicate that

[1]*'Burbot' is a more suitable name for the fish termed 'ling' in Part I of these studies (4).*

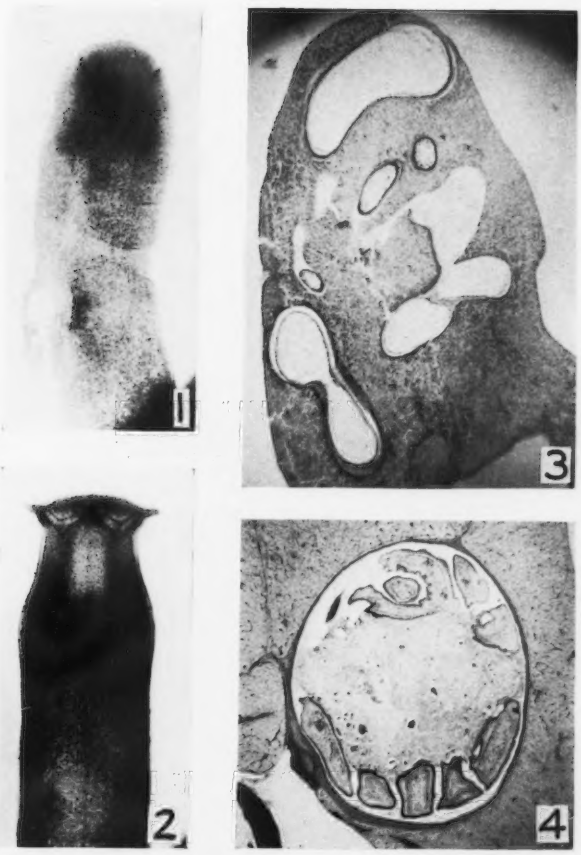


FIG. 1. *Photomicrograph of the stained and mounted scolex of a young plerocercoid of T. nodulosus just prior to its encystment. This specimen was taken from the liver of a burbot of the year collected July 11, 1943. The anlagen of the scolex hooks can be distinguished (×40).* FIG. 2. *Photomicrograph of the stained and mounted scolex of a fully-formed plerocercoid taken from the completed cyst in the liver of a burbot of the year collected Sept. 6, 1943. The completed hooks and the bothrium are visible (×40).* FIG. 3. *Photomicrograph of a portion of a section through the liver of a burbot of the year collected July 25, 1944. The sections of plerocercoids showing are of four distinct worms, well scattered throughout the liver tissue (×20).* FIG. 4. *Photomicrograph of a portion of a section through the liver of a yearling burbot collected June 10, 1944. The cyst contains a single plerocercoid. Contrast the clearly defined, compact cyst with the scattered plerocercoids shown in Fig. 3 (×18).*

this is not a true stage but that a gradual transformation to the plerocercoid is taking place.

Examples of a later stage in the infestation of burbot livers were found in a collection of burbot of the year made July 25, 1944. Eighteen livers were examined of which half contained parasites. The infected livers were considerably enlarged and gorged with blood. In some the worms lying near the liver surface could be seen without dissection (Fig. 5). The most heavily

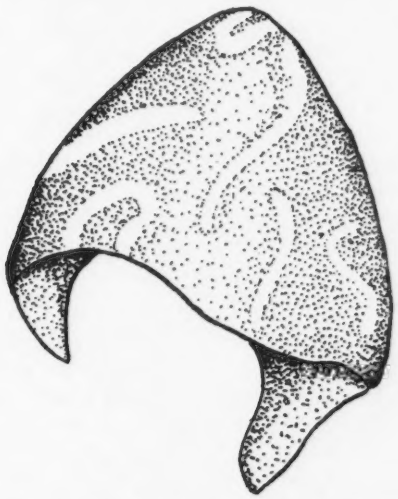

FIG. 5. *Sketch of the ventral aspect of the liver of a burbot of the year collected July 25, 1944. The irregular white areas represent young plerocercoids of T. nodulosus embedded just below the surface of the liver (×7).*

infested burbot had evidently died by this time as only one to four worms were found per liver. These were larger than the July 11th specimens and some of them had fully formed scolices with hooks similar to the adult. A photomicrograph of a section through one of these livers that contained four worms is shown in Fig. 3. A thin wall of connective tissue has formed around the plerocercoids in most places. The worms, however, are not yet tightly coiled, but lie in loose folds in the liver tissue.

The next collection of burbot of the year, now 6.0 cm. long, was made on Sept. 6, 1943. Their livers contained compact, spindle-shaped cysts, 3.0 × 2.5 mm., in which lay the now tightly coiled plerocercoids, 2.5 to 3.0 cm. long. Each was provided with a fully formed scolex bearing two bothria and four hooks identical in size and disposition with those of the adult (Fig. 2). Often two and sometimes three worms were found in a single cyst. As pointed out by Scheuring (7) the worm's body juices destroy the liver tissue to provide nourishment and as the destruction proceeds neighbouring parasites 'eat into' each other and come to lie in the same cavity in the liver. In this way the

early loose network of parasites is finally contracted into one or two compact cysts. A section through one of these shows this change clearly. The greatly thickened cyst wall consists of an outer layer of circularly arranged connective tissue fibres and an inner cellular layer. The whole wall is apparently the result of the action of substances from the parasite's body on the liver tissue.

Within the coils of the plerocercoid, which are arranged around the periphery of the cyst, is an opaque, yellowish coagulum consisting of dissolving liver tissue, food for the worm, and excretory material from the parasite (7).

On June 10, 1944, 21 burbot from 8.1 to 14.4 cm. long were obtained. From their size these were judged to be fish in their second summer. The livers of 11 of these contained cysts of *T. nodulosus*. These cysts were identical in appearance to those found the previous September (Fig. 4) and were evidently carry-overs from the previous spring's infection. The plerocercoids in them (one to three per cyst), though larger than the September worms, were noticeably less active and in many the posterior half was irregular, bloated, and degenerate; the last centimetre appeared in many to be incapable of muscular activity. A similar degeneration was observed by Scheuring (7) in plerocercoids of *T. nodulosus* in trout livers.

No new infection was found in these second summer burbot, nor was any found in a further catch of yearlings examined in July. By the end of their first summer burbot cease feeding on plankton and change from a free swimming life to a bottom dwelling one. In the second summer they live among rocks, near shore, and feed on bottom organisms. It is not surprising, therefore, that only first summer burbot become parasitized with *T. nodulosus*. It seems probable that the cysts disappear by the third summer as no burbot older than yearlings have been found to have cysts in their livers. It was pointed out in Part I of these studies (4) that it is mainly the smaller pike that are infested with adults of *T. nodulosus*. This fact is explained by the confinement of the plerocercoids to burbot fry and yearlings; these small fish are, of course, eaten mainly by the small pike, and larger game is sought by the larger pike.

The failure of perch to serve as second intermediate hosts for *T. nodulosus* is possibly due to the lateness of the season at Lesser Slave Lake. The perch in this lake do not spawn until June and perch of the year are not caught in seine hauls until July. By this time the procercoid stage of *T. nodulosus* must be almost absent from the copepods that these young perch would eat.

## Summary of the Life History of *T. nodulosus*

A fairly complete account of the life history of *T. nodulosus* is contained in this paper and the two (4, 5) that preceded it; for convenience it is briefly summarized here.

The adult of *T. nodulosus* is found in the gut of the pike, *Esox lucius*; pike under three pounds are the usual hosts. It is reported as an adult from 22 species of freshwater fishes in Europe but Scheuring (7) believes all but

the pike to be accidental definitive hosts. Sexual maturity is reached in May; the worms die and leave the host's gut at this time and in early June, scattering the ripe eggs in the water.

The eggs hatch in a few hours into the ciliated coracidia. These have a brief (one to two day) life span. To develop further they must be swallowed by the copepod, *Cyclops bicuspidatus* (in Europe *Cyclops strenuus* is the first intermediate host). The procercoids develop in the copepods in 10 days to two weeks. They are then ready to infect the second intermediate host, which, in Lesser Slave Lake, is the burbot. In Europe over 30 species of freshwater fishes may serve as second intermediate hosts (7).

Burbot fry probably become infected in June. The procercoids make their way through the gut wall and into the body cavity and from there penetrate the liver. During July the liver penetration is completed, cyst formation begins, and the transformation to the plerocercoid takes place. By the end of the summer the plerocercoids are completely enclosed in small, whitish cysts in the liver. They are now ready to infect the definitive host and complete the cycle. Plerocercoids that remain uneaten begin to degenerate during the second summer and none are found in adult burbot.

## Acknowledgments

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